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Attn: Patent Application Branch

RE: Filing of Patent Application
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Dear Sir:

Enclosed for filing is a patent application of Toshihiko Suzuki, Hidenori Hoshi and Hiroaki Endo for an APPARATUS FOR RECORDING SIGNALS ON DISK RECORDING MEDIUM, the application comprising a Specification of 48 pages; 25 numbered Claims, including six Independent numbered Claims; 20 sheets of Formal Drawings (Figures 1-22); an Abstract and our check in the amount of \$1,014.00 in payment of the filing fee, which has been calculated as follows: \$690.00 base filing fee, \$234.00 for three Independent claims in excess of three and \$90.00 for five claims in excess of twenty.

A "Combined Declaration and Power of Attorney for Patent Application" will be filed at a later date.

Claim will be made under 35 U.S.C. § 119 for the benefit of the filing date of Japanese Patent Application Nos. 11-234287 (filed August 20, 1999); 11-257628 (filed September 10, 1999); 11-304137 (filed October 26, 1999) and 11-350467 (filed December 9, 1999) certified copies of which will be filed in due course.

Authorization is given for the charging of any further fee for effecting filing to our Deposit Account No.18-1644.

Respectfully submitted,

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Apparatus for Recording Signals on

Disk Recording Medium

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an apparatus for recording signals such as image signals on a disk recording medium and, more particularly, to control of management information of recorded signals.

10 Related Background Art

Conventionally, a video tape recorder which records analog video signals on magnetic tapes is available as an image recording apparatus for recording video signals on a recording medium. However, with rapid progress of digital signal processing technologies, digital recording/playback apparatuses which record analog video signals on a recording medium by converting the signals into digital video signals are becoming popular at present.

20 Such digital recording/playback apparatuses include a digital VTR, a digital video disk apparatus which records signals on a solid-state disk or magneto-optical disk, and a solid-state memory video apparatus which records signals in a solid-state memory
25 such as a flash memory or an SRAM.

These digital recording/playback apparatuses load a video signal obtained by an image pickup device such

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as a CCD and convert the signal into a digital signal by A/D conversion. The apparatuses reduce the information amount by compression-encoding this digital video signal. In this manner, these apparatuses can
5 record a large amount of image information in a small recording capacity.

Schemes used as this compression encoding are discrete cosine transform (to be referred to as DCT hereinafter) which is orthogonal transformation having
10 the highest compression efficiency, and a variable-length coding scheme. To perform compression encoding, a single image is first segmented into a plurality of blocks each having x horizontal pixels and y vertical pixels, and DCT transform is performed for
15 each block. A DCT coefficient after the transform is divided by a certain divisor, and the remainder is rounded, thereby performing quantization. By using the characteristic that a quantized image is concentrated in low-frequency components, the number of bits of
20 high-frequency components is reduced. In this way, the information amount is greatly reduced.

The information amount can be further compressed by performing variable-length encoding, e.g., Huffman coding, which assigns to the quantized data a code
25 length corresponding to the occurrence frequency of the data.

Furthermore, greater compression can be attained

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by combining interframe predictive encoding which calculates the difference between frames, by using the characteristic that a motion image has a strong correlation between frames.

5 Of this type of recording/playback apparatuses, the capacities of disk media of disk apparatuses are rapidly increasing in recent years. Consequently, apparatuses which record and play not only audio signals but video signals in and from a disk medium for
10 a long time have been proposed. For example, a technique has been proposed which uses a recording format based on high-efficiency encoding such as MPEG using, e.g., DCT and variable-length encoding described above, and which can realize a recording/playback
15 apparatus which records video signals for one hour or more at data rates of about 4 Mbps and 10 Mbps. Furthermore, disk media themselves are being reliably decreased in size and increased in capacity.

 In an image recording apparatus which records
20 video signals on a disk medium by reducing the information amount by compressing the signals by combining the aforementioned compression techniques, the information amount varies in accordance with an image because variable-length encoding is used.
25 Therefore, a rate control means for holding the information amount constant is used to uniformize the recording rate of images, thereby recording images in a

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predetermined recording media capacity within a predetermined time.

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This rate control uniformizes the rate by writing compressed data having variations into a certain
5 predetermined buffer and reading out the data at a constant rate. That is, buffer control is performed such that if the data may exceed a predetermined value of the buffer, the quantization level described above is increased to raise the compression ratio; if the
10 buffer does not satisfy the predetermined value, the quantization level is decreased to lower the compression ratio.

In constant bit rate recording (CBR recording), the recording rate is held constant by giving priority
15 to the target time of recording on a recording medium. Hence, if an input image moves fast or has a wide color band, quantization becomes coarse to make the image nonuniform between frames. Therefore, an image recording apparatus which performs variable bit rate
20 recording (VBR recording) by attaching importance to image quality has been proposed. This VBR recording performs encoding giving priority to image quality by holding the quantization level of recording at a substantially constant value, while allowing
25 fluctuations of the recording rate.

A recording/playback apparatus like this uses management information called Table of Contents (to be

referred to as a TOC hereinafter) to control video data recording and playback operations. When video data obtained by image pickup is recorded on a recording medium, the TOC information is recorded in an area
5 formed on the inner peripheral side of the disk medium independently of an area for recording video data. In playback operation, the TOC information is read out from the disk medium and held in an internal memory of the apparatus. On the basis of this TOC information,
10 the position of access to the disk medium and diverse operations such as video data playback management are controlled.

Examples of operations managed using the TOC are an operation of linking data of one scene, which are
15 discontinuously recorded on a recording medium, and continuously displaying back the data, an operation of deleting a scene once obtained by image pickup, and an operation of recording a scene newly obtained by image pickup in a free space formed by deletion.

20 In any of these operations, video data is recorded in an area (video recording area) formed near the center in the radial direction of a disk medium, and the TOC information is saved in an area (system information management area) formed inside the image
25 recording area. Note that no data can be recorded in the outer periphery of the disk.

Since the TOC is important information necessary

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to recording/playback, the reliability is improved by, e.g., recording the TOC a plurality of times in the system management area of a disk.

In conventional image pickup recording/playback apparatuses, the TOC is recorded on a disk after video data is completely written in the medium. That is, after the recording end pointer (address) of video data on a disk is determined, various pieces of information including an end pointer and start pointer are recorded as the TOC information.

If, therefore, one recorded scene extends over a long time period, no TOC information may be recorded for long periods of time.

Also, a system using a disk medium can rapidly access data in the disk medium, so recording or playback access to the disk medium is usually intermittently performed. Between this disk access operation and other operations, large differences are produced in consumption power such as motor driving power, head driving power, and write laser power.

When a series of recording operations are performed with battery driving, therefore, the battery supply voltage lowers with an abrupt rise of the consumption power upon disk access. This sometimes makes the recording operations of the system impossible to perform.

Especially when the TOC information is to be

recorded, the write operation is performed by moving a recording/playback head mechanism from the video recording area for recording video data to the system management area in a remote position. Hence, if the
5 battery amount remains to such an extent that a video data recording operation is marginally possible, the TOC information cannot be written in the worst case.

If the TOC information is missing, the start pointer, end pointer, attribution, and the like of
10 recorded video data are unknown, so disk medium playback control cannot be performed.

Also, even if the reliability of the TOC data is improved as described previously, recording is sometimes abnormally terminated in the middle of a scene by, e.g., careless handling by a user, running
15 out or abrupt discharge of a battery, a defect of a recording medium, or some external cause. In a case like this, actually recorded images and sounds and additional data sometimes disagree with the contents of
20 the TOC. This makes playback of the scene based on the TOC impossible.

SUMMARY OF THE INVENTION

It is an object of the present invention to solve
25 the above conventional problems.

It is another object of the present invention to reliably record management information such as TOC

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second area.

Other objects and features of the present invention will become apparent from the following detailed description of embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the configuration of a recording apparatus according to an embodiment of the present invention;

Fig. 2 is a block diagram showing the arrangement of a recording unit shown in Fig. 1;

Fig. 3 is a view showing the directory structure of the apparatus shown in Fig. 1;

Fig. 4 is a view showing a TOC processed by the apparatus shown in Fig. 1;

Fig. 5 is a view showing the major components of an electric power unit of the apparatus shown in Fig. 1;

Fig. 6 is a flow chart for explaining an operation of the apparatus shown in Fig. 1;

Fig. 7 is a view showing another example of the TOC processed by the apparatus shown in Fig. 1;

Fig. 8 is a flow chart for explaining another operation of the apparatus shown in Fig. 1;

Fig. 9 is a view showing a recording format on a disk in the apparatus shown in Fig. 1;

Fig. 10 is a block diagram showing the configuration of a recording apparatus according to another embodiment of the present invention;

Fig. 11 is a view for explaining picture
5 rearrangement by the apparatus shown in Fig. 10;

Fig. 12 is a view for explaining encoding by the apparatus shown in Fig. 10;

Fig. 13 is a timing chart showing the recording timings of TOC data in the apparatus shown in Fig. 1;

10 Fig. 14 is a timing chart showing the recording timings of an image signal in the apparatus shown in Fig. 10;

15 Figs. 15A and 15B are graphs showing a picture change detection process by the apparatus shown in Fig. 14;

Fig. 16 is a block diagram showing the configuration of a recording apparatus according to still another embodiment of the present invention;

20 Fig. 17 is a graph for explaining the operation of an audio change detection circuit of the apparatus shown in Fig. 16;

Fig. 18 is a timing chart showing the recording timings of TOC data in the apparatus shown in Fig. 16;

25 Fig. 19 is a block diagram showing the configuration of a recording apparatus according to still another embodiment of the present invention;

Fig. 20 is a view showing a recording format on a

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Fig. 21 is a view showing recorded data on the disk shown in Fig. 20; and

Fig. 22 is a view showing TOC data processed by
5 the apparatus shown in Fig. 21.

Preferred embodiments of the present invention will be described in detail below with reference to the accompanying drawings.

Fig. 1 is a block diagram showing the configuration of a recording/playback apparatus 100 according to the first embodiment of the present invention. Referring to Fig. 1, this recording/playback apparatus 100 comprises an optical system 101 including, e.g., a lens and a lens controller, an image pickup processing unit 102, an A/D converter 103, a camera signal processing unit 104, a video signal processing unit 105, a D/A converter 106, an analog video signal output unit 107, a display unit 108, a data bus 109, a memory 110, a memory controller 111, a CPU 112, a disk unit 113, an electric power unit 114 such as a battery, and an operation unit 115 including, e.g., a power switch and a recording trigger switch. For the sake of simplicity, the electric power unit 114 is connected only to the CPU 112 in Fig. 1. In reality, however, electric power is supplied to all

units requiring power via power lines.

In this recording/playback apparatus 100, the optical system 101 including a lens performs iris control, focusing control, zoom control, and the like.

5 The image pickup processing unit 102 photoelectrically converts an object image (not shown) by a CCD (Charge-Coupled Device) or the like. The A/D converter 103 converts the obtained analog image signal into a digital signal. The camera signal processing unit 104

10 performs predetermined data processing such as gamma correction and white balance adjustment for the digital image data.

In recording operation, the video signal processing unit 105 segments the output image data from

15 the camera signal processing unit 104 into a plurality of blocks each composed of a plurality of pixels, performs orthogonal transformation such as DCT for each block, and quantizes and encodes the blocks.

Generally, a change between two continuous frames is

20 small in motion image data, so an image of interest has high correlations with images before and after that image. By using this characteristic, the differences between an image of interest and images of frames before and after the image of interest are encoded to

25 perform image compression. An MPEG scheme is used most frequently by which the difference between images is obtained after motion compensation is performed to

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reduce the redundancy in the time axis, and orthogonal transformation such as DCT and variable-length coding are performed on the obtained differential data.

The image data compressed and encoded by the video
5 signal processing unit 105 is output to the disk unit
113 and recorded on a magnetooptical disk, as will be
described later.

In playback operation, image data reproduced by the disk unit 113 is output to the video signal processing unit 105. The video signal processing unit 105 performs decoding, which is the reverse of encoding performed during recording, for the reproduced image data to expand its information amount, and outputs the decoded data to the D/A converter 106.

15 The D/A converter 106 converts the output digital
video signal from the video signal processing unit 105
into an analog signal. The video signal output unit
107 converts this analog signal into a signal following
a television system, such as NTSC or PAL, and outputs
20 the signal. The display unit 108 is, e.g., a
viewfinder or a liquid crystal monitor and allows a
user to monitor an image currently being picked up, or
a reproduced image, on the basis of the output analog
video signal from the D/A converter 106.

25 The CPU 112 controls the operation of the whole
recording/playback apparatus 100 via the data bus 109.
The CPU 112 also controls parameters in the image

pickup processing unit 102, the camera signal processing unit 104, and the video signal processing unit 105. The memory control unit 111 controls data write to and read from the memory 110 in accordance with a control signal from the CPU 112.

The arrangement of the disk unit 113 will be described below with reference to Fig. 2.

Fig. 2 is a block diagram showing the arrangement of the disk unit 113.

Referring to Fig. 2, this disk unit 113 includes a magnetooptical disk 201, a magnetic head 202, a driver 203 of the magnetic head, an optical pickup 214, and a preamplifier 205.

A disk motor 208 rotates the disk 201. A thread mechanism 210 moves the magnetic head 202 and the optical pickup 214 in the radial direction of the disk.

In recording operation, this optical pickup 214 irradiates the disk 201 with a laser beam emitted from a semiconductor laser element (not shown) such as a laser diode. At the same time, an encoder 204 performs error correction encoding and channel encoding such as digital modulation for video data input via an interface 207. The driver 203 drives the magnetic head 202 with a driving signal modulated on the basis of the data processed by the encoder 204. In accordance with this modulated driving signal, the magnetic head 202 records the data by performing magnetic field

modulation on the disk 201.

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In playback operation, the pickup 214 irradiates the disk 201 with a laser beam emitted from the semiconductor laser element (not shown), detects the polarized light amount of reflected light caused by the magnetic Kerr effect, and supplies the detected amount to the preamplifier 205. The output signal from the preamplifier 205 is subjected to demodulation and error correction decoding by a decoder 206, and output to the video signal processing unit 105 shown in Fig. 1 via the interface 207.

A DC motor 211 drives the thread mechanism 210. A servo digital signal processor (DSP) 213 controls the rotational speed of the disk and servo operations of the thread mechanism 210 by using a motor driver 209 and a servo driver 212. More specifically, the servo DSP 213 controls, e.g., rotational servo of the disk and focusing servo, tracking servo, and seek servo of the pickup system.

The bus I/F 207 exchanges recording/playback data with the data bus 109 shown in Fig. 1. That is, the bus I/F 207 controls input and output of data with respect to the encoder 204 during recording and controls input and output of data with respect to the decoder 206 during playback.

A file (TOC data) structure used in this embodiment will be described below.

First, TOC data processing by the CPU 112 will be explained.

In this embodiment, as shown in Fig. 9, an inner peripheral portion 901 of a disk is used as a system management area, and TOC data is recorded in this
5 system management area 901. Video and audio data are recorded in a video recording area 902.

The CPU 112 writes TOC data, which is read out from a disk by the disk unit 113, into the memory 110
10 via the memory control unit 111. In this state, the CPU 112 updates the TOC data stored in the memory 110 in accordance with a recording or playback operation. When recording is stopped by the recording trigger switch or when the disk is to be ejected, the CPU 112
15 records the TOC data in the system management area 901.

Fig. 3 shows the file directory structure of the recording/playback apparatus 100. Referring to Fig. 3, a disk medium 301 is defined as uppermost hierarchy 0. In lower hierarchy 1, application attributions such as
20 video 302, audio 303, a still image 304,..., can be classified. In lower hierarchy 2 of any file (in Fig. 3, the video 302) defined in hierarchy 1, video A 305, video B 306, video C 307,..., can be classified in accordance with the dates of image pickup.
25 Subsequently, in lower hierarchy 3 of any file (in Fig. 3, the video A 305) defined in hierarchy 2, scene 1 (308), scene 2 (309), scene 3 (310),..., partitioned

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by ON/OFF of the trigger pointer can be classified.
Furthermore, in lower hierarchy 4 of any file (in
Fig. 3, scene 1 (308)) defined in hierarchy 3, an image
pickup start pointer 311 (address information), an
5 image pickup end pointer 312 (address information), a
link pointer 313 (address information) which allows
jump during editing and playback,..., of scene 1 can be
classified.

Details of the TOC of the recording/playback
10 apparatus 100 having this directory structure are shown
in Fig. 4. Fig. 4 depicts the structure of the TOC.
This structure is roughly classified into a TOC
identification header portion containing all 0s or all
1s, system information, and a management information
15 table portion. For each item, a start pointer 401, an
attribution 402, an end pointer 403, and a link pointer
404 can be defined in units of a few bytes.

As an example, playback control of a file in
directory hierarchy 3 shown in Fig. 3 will be explained
20 with reference to Fig. 4.

First, playback is started from the address,
indicated by a start pointer A of address 0001 in the
management information table portion, of the video
recording area on a disk medium. After the recorded
25 data is continuously reproduced to an address indicated
by an end pointer B, the operation jumps to address
AAAA indicated by a link pointer. Subsequently,

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5 playback is started from the address, indicated by a start pointer C, of the video recording area on the disk medium. When the recorded data is completely reproduced to an address indicated by an end pointer D, the playback is completed. Link pointer 0000 in address AAAA is an index indicating the end of playback. The playback of image data of each scene is controlled on the basis of attribution information.

10 In this embodiment, as shown in Fig. 4, a U flag (Urgency Flag) is set in the attribution information 402 of the system information portion. This U flag is 1-bit digital information used to check whether a TOC recorded in the system management area of a disk is the latest one. The use of this U flag will be described
15 in detail later.

Fig. 5 is a view showing the arrangement of the electric power unit 114 shown in Fig. 1. This electric power unit 114 includes a power reduction detector and monitors and detects a decrease in electric power.
20 Referring to Fig. 5, this electric power unit 114 comprises a battery 501, DC-DC converters 502 and 503, resistors 504, 505, and 506 for dividing voltage, and comparators 508 and 509.

25 Electric power from the battery 501 is converted into a predetermined voltage by the DC-DC converter 502 and supplied to each circuit of the recording/playback apparatus 100. The DC-DC converter 503 and the

subsequent elements detect power reduction. That is, the output voltage from the DC-DC converter 503 is divided to obtain a first threshold value (Th1) by the resistors 504 and 505 and a second threshold value
5 (Th2) by the resistors 506 and 507. Note that Th1 > Th2.

The comparator 508 compares the battery voltage 501 with Th1 and outputs a binary digital signal indicating the comparison result. On the basis of the
10 output from this comparator 508, the CPU 112 instructs to display a power reduction warning if the battery voltage is equal to or lower than Th1. The comparator 509 compares the battery voltage 501 with Th2 and outputs a binary digital signal indicating the
15 comparison result. On the basis of the output from this comparator 509, the CPU 112 instructs to shut down the power supply if the battery voltage is equal to or lower than Th2.

A control operation by the CPU 112 in this
20 embodiment will be described below with reference to Fig. 6. Fig. 6 is a flow chart for explaining recording and playback of image data and TOC data performed by the CPU 112.

First, after power-on in step S601, the CPU 112
25 causes the disk unit 113 to read out TOC data from the system management area 901 on the disk 201 and write the TOC data in the memory 111. In step S602, the CPU

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accordance with this recording stop position, in step S613 the CPU 112 updates the contents of the TOC data stored in the memory 111, so as to reflect the recording start pointer, end pointer, and link pointer of the image data currently being recorded, thereby
5 urgently removing the TOC information.

In step S613, unlike normal recording processing of TOC data, the TOC data is written following the trailing end of the image data whose recording into the
10 video information recording area 902 is stopped, without moving the head mechanism of the disk unit 113 to the system management area 901. After performing this TOC data recording processing in step S613, the CPU 112 waits for the next instruction.

On the other hand, if the battery power is not low
15 in step S608 and a recording stop instruction is detected in step S609, in step S610 the CPU 112 updates the contents of the TOC data stored in the memory 111, so as to reflect the start pointer, end pointer, and
20 link pointer of the latest recorded image data, and sets the U flag to "0". In step S611, the CPU 112 moves the head mechanism to the system management area 901 and writes the TOC information having the updated contents and the U flag "0" in this system management
25 area 901.

If in step S602 the U flag is set to "1" indicating that the TOC does not show the latest

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contents, the flow advances to step S614.

In this case, the TOC recorded in the system management area 901 has not been updated to the latest information. Therefore, the CPU 112 sequentially
5 searches the video recording area 902 of the disk 201 from a position indicated by the final end pointer of the latest TOC information recorded in the system management area 901, and reads out the latest TOC information recorded in the video information recording
10 area 902 as described previously. In step S615, on the basis of the readout latest TOC information, the CPU 112 updates the contents of the TOC information stored in the memory 111 and sets the U flag to "0". In step S616, the CPU 112 records this TOC information in the
15 system management area 901 which is the original recording area of TOC information.

The CPU 112 continues the above operation until power-off or until the battery voltage becomes lower than Th2 and then the comparator 509 shown in Fig. 5
20 outputs a signal indicating a power-supply voltage drop.

In this embodiment as described above, even when the battery voltage lowers during recording, TOC information reflecting the latest recorded contents can
25 be reliably recorded.

The second embodiment will be described next. A recording/playback apparatus of this embodiment has the

same configuration as the image pickup recording/playback apparatus explained with reference to Figs. 1, 2, and 5 in the first embodiment, so a detailed description thereof will be omitted.

5 In the second embodiment, a TOC is constructed as
shown in Fig. 7. One-bit remove information indicating
that this TOC information is not normally recorded and
its contents do not reflect the latest recorded
contents can be described in the MSBs of attribution
10 data 402' in a management information table portion.

Processing by a CPU 112 in this embodiment will be described below with reference to a flow chart in Fig. 8.

First, after power-on in step S801, the CPU 112 causes a disk unit 113 to read out TOC data from a system management area 901 on a disk 201 and write the TOC data in a memory 111. In step S802, the CPU 112 checks for all MSBs in the attributions 402' of the TOC stored in the memory 111. In this embodiment, if the MSB of the attribution 402' is "0", this indicates that the TOC is normally recorded in the system management area 901 of the disk 201 when the last image data is recorded; if the MSB is "1", this indicates that the TOC is not normally recorded in the system management area 901 of the disk 201 when the last image data is recorded and that the contents of this TOC do not correspond to the latest recorded contents.

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of TOC data, the TOC data is written following the trailing end of the image data whose recording into a video information recording area 902 is stopped, without moving a head mechanism of the disk unit 113 to the system management area 901. After performing this TOC data recording processing in step S813, the CPU 112 waits for the next instruction.

On the other hand, if the battery power is not low in step S808 and a recording stop instruction is detected in step S809, in step S810 the CPU 112 updates the contents of the TOC data stored in the memory 111, so as to reflect the start pointer, end pointer, and link pointer of the latest recorded image data, and sets the MSB of the attribution 402' to "0". In step S811, the CPU 112 moves the head mechanism to the system management area 901 and writes the updated TOC information in this system management area 901.

If in step S802 the MSB of the attribution 402' is set to "1" indicating that the TOC does not show the latest contents, the flow advances to step S814.

In this case, the TOC recorded in the system management area 901 has not been updated to the latest information. Therefore, the CPU 112 sequentially searches the video recording area 902 of the disk 201 from a position indicated by the final end pointer of the newest TOC information recorded in the system management area 901, and reads out the latest TOC

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Fig. 10 is a block diagram showing a recording

apparatus 1000 according to this embodiment of the present invention.

5 This recording apparatus 1000 comprises an image pickup unit 1001, a picture rearrangement circuit 1002, a switch 1003, a subtractor 1004, a DCT (Discrete Cosine Transform) circuit 1005, a quantization circuit 1006, a variable-length encoding circuit 1007, an inverse quantization circuit 1008, an IDCT (Inverse Discrete Cosine Transform) circuit 1009, an adder 1010, 10 a motion compensation prediction circuit 1011, a switch 1012, a buffer 1013, a rate control circuit 1014, a recording processing circuit 1015, a magneto-optical disk 1016, a picture change detection circuit 1017, a TOC memory 1018 for storing TOC information, a TOC 15 control circuit 1019, and an operation unit 1020 which includes, e.g., a power switch and a recording trigger switch.

The operation will be described next.

20 A digital image signal obtained by the image pickup unit 1001 is input in units of frames to the picture rearrangement circuit 1002. This picture rearrangement circuit 1002 has a memory capable of storing a digital image signal having a plurality of frames. By using this memory, the picture 25 rearrangement circuit 1002 rearranges frames of the input image signal and outputs the signal.

The operation of the picture rearrangement circuit

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The output image data from the picture

rearrangement circuit 1002 is also input to the motion compensation prediction circuit 1011 and the picture change detection circuit 1017.

5 The quantized data is inversely quantized by the inverse quantization circuit 1008 and subjected to IDCT by the IDCT circuit 1009. The switch 1012 is turned off to supply the image data subjected to IDCT to the motion compensation prediction circuit 1011. The motion compensation prediction circuit 1011 generates
10 and outputs a predictive image for the subsequent inter-encoding.

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15 The quantized data is also input to the variable-length encoding circuit 1007 where the data is variable-length-encoded. The encoded data is input to the buffer 1013. When reaching a certain predetermined data amount, the image data in the buffer 1013 is output to the recording processing circuit 1015. This recording processing circuit 1015 has an arrangement as shown in Fig. 2 and records the data on the
20 magneto-optical disk 1016. The recording processing circuit 1015 can record data at a higher data rate than the rate of image data input to the buffer 1013. In practice, the recording processing circuit 1015 intermittently reads out data in units of predetermined
25 amounts of data from the buffer 1013 and records the readout data.

To perform the inter-encoding, the switch 1003 is

closed to a terminal B. The subtractor 1004 is used to lower the redundancy in the time axis. This subtractor 1004 outputs the difference between the output image data from the picture rearrangement circuit 1002 and
5 the predictive image data from the motion compensation prediction circuit 1011 to the terminal B of the switch 1003.

The output data from the subtractor 1004 is input to the DCT circuit 1005 via the switch 1003 and
10 orthogonally transformed. The quantization circuit 1006 quantizes the orthogonally transformed image data in accordance with a quantization coefficient determined by the rate control circuit 1014. The quantized image data is input to the inverse
15 quantization circuit 1008 and the variable-length encoding circuit 1007.

The output image data from the picture rearrangement circuit 1002 is also input to the motion compensation prediction circuit 1011 and the picture
20 change detection circuit 1017.

The quantized data is inversely quantized by the inverse quantization circuit 1008 and subjected to IDCT by the IDCT circuit 1009. In this inter-encoding, the switch 114 is turned on to allow the adder 1010 to add
25 the image data from the IDCT circuit 1009 and the predictive image data from the motion compensation prediction circuit 1011, thereby obtaining decoded

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image data. This decoded image data is input to the motion compensation prediction circuit 1011 for the subsequent image encoding. The motion compensation prediction circuit 1011 outputs predictive image data and a motion vector. This motion vector is input to the variable-length encoding circuit 1007.

The quantized data is input to the variable-length encoding circuit 1007 where the data is variable-length-encoded. The encoded data is input to the buffer 1013. When reaching a certain predetermined data amount, the image data in the buffer 1013 is output to the recording processing circuit 1015. The recording processing circuit 1015 records the image data on the disk 1016.

Recording of a TOC as index information in this embodiment will be described below.

Also in this embodiment, TOC information is recorded in a system management area 901 on a disk shown in Fig. 9.

When the power supply is turned on by the operation unit 1020, the TOC control circuit 1019 stores TOC information, read out from the system management area on the disk 1016 by the recording processing circuit 1015, in the TOC memory 1018. In accordance with recording processing, the TOC control circuit 1019 updates the contents of the TOC information stored in the TOC memory 1018. When the

stop of recording is designated by the operation unit 1020, the TOC control circuit 1019 reads out the latest TOC information stored in the TOC memory 1018. The recording processing circuit 1015 records the readout TOC information in the system management area of the disk 1016.

Furthermore, the TOC control circuit 1019 records the TOC information stored in the TOC memory 1018 into the disk 1016 in accordance with an output from the picture change detection circuit 1017.

This picture change detection circuit 1017 reads out image data of a plurality of frames stored in the picture rearrangement circuit 1002 and calculates a difference A

$$A = \int |\text{Frame1}(Y) - \text{Frame2}(Y)| \dots (1)$$

in luminance information between frames. If this difference A is larger than a certain threshold value TH, i.e., if $A > TH$, the picture change detection circuit 1017 outputs a control signal indicating a picture change to the TOC control circuit 1019.

When detecting this control signal, the TOC control circuit 1019 controls the TOC memory 1018 to record TOC information which reflects the contents of recording up to the point, in the system management area of the disk 1016 by the recording processing circuit 1015, by using a period during which no image data is recorded.

1303 is recorded in the disk 1016. So, all recorded data up to 1303 can be correctly reproduced.

In scene 2, TOC information is recorded in the system management area at picture change detection
5 timings 1304 and 1305. In this example, the power supply is shut down at timing 1306 before recording stop operation, so recording is not normally stopped. However, TOC information is recorded on the disk 1016 at the timing 1305 at which a picture change is
10 detected. The TOC information recorded at this timing 1305 reflects the contents of image data recorded up to 1305. In playback, therefore, data from the start of recording of scene 2 to the timing 1305 at which a picture change is lastly detected can be correctly
15 reproduced.

In this embodiment, a picture change is detected by the difference between frames. However, a picture change can also be detected by another method.

For example, as shown in Figs. 15A and 15B, a
20 histogram of the directions of motion vectors calculated by the motion compensation prediction circuit 113 is obtained in one frame. If the correlation between the motion vectors in one frame is low, a picture change is detected.

25 Referring to Fig. 15A, motion vectors having angles of 0 to 90° is largest in number, so changes between pictures are obviously small. Referring to

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the encoded image data to the buffer 1024. The multiplexer 1025 multiplexes the image data stored in the buffer 1013 and the audio data stored in the buffer 1024 such that pictures and audio are synchronized.

5 The multiplexed data is output to the recording processing circuit 1015.

Recording of a TOC as an important point of the present invention will be described next.

Also in this embodiment, TOC information is
10 recorded in a system management area 901 on a disk shown in Fig. 9.

When the power supply is turned on by an operation unit 1020, a TOC control circuit 1019 stores TOC information read out from the system management area on
15 a disk 1016 by the recording processing circuit 1015, in a TOC memory 1018. In accordance with recording processing, the TOC control circuit 1019 updates the contents of the TOC information stored in the TOC memory 1018. When the stop of recording is designated
20 by the operation unit 1020, the TOC control circuit 1019 reads out the newest TOC information stored in the TOC memory 1018. The recording processing circuit 1015 records the readout TOC information in the system management area of the disk 1016.

25 In this embodiment, the TOC control circuit 1019 further records the TOC information stored in the TOC memory 1018 into the disk 1016 in accordance with an

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output from the audio change detection circuit 1022.

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This audio change detection circuit 1022 has a comparator and, as shown in Fig. 17, outputs a high-level signal to the TOC control circuit 1019 when
5 a period during which the level of an input audio signal is lower than a predetermined threshold A_{th} continues for a predetermined time T_{th} or more. When the audio change detection circuit 1022 outputs this high-level control signal, the TOC control circuit 1019
10 controls the TOC memory 1018 to record TOC information which reflects the contents of recording up to the point, in the system management area of the disk 1016 by the recording processing circuit 1015, by using a period during which neither image data nor audio data
15 are recorded.

Fig. 18 is a view for explaining TOC recording timings.

Symbols ★ in Fig. 18 indicate timings at which the audio change detection circuit 1022 outputs a control
20 signal indicating that a period in which the input audio level is lower than the threshold value is detected. In scene 1, TOC information is recorded in the system management area 901 of the disk 1016 at the timings of audio change detection 1801, temporary stop
25 1802, and stop of recording 1803.

Also in this embodiment, image data is output to the recording processing circuit 1015 via a buffer

1013. Also, the recording processing circuit 1015 can record data on the disk 1016 at a higher rate than the data rate of image data input to the buffer 1013.

That is, the recording processing circuit 1015
5 performs intermittent recording on the disk 1016. As shown in Fig. 14, therefore, non-record periods are produced during recording of image data. Fig. 14 shows recording periods 1401 and data non-record periods 1402. Accordingly, when a picture change is detected
10 at timing 1401a, TOC information can be recorded, even during image data recording, by moving the head to the system management area 901 in a data non-record period 1402a.

Also, in scene 1 of Fig. 18, recording is normally
15 stopped at timing 1803. Hence, TOC information reflecting data recorded up to this stop of recording 1803 is recorded in the disk 1016. So, all recorded data up to 1803 can be correctly reproduced.

In scene 2, TOC information can be recorded in the
20 system management area on the disk 1016 at audio change detection timings 1804 and 1805. In this example, the power supply is shut down at timing 1806 before recording stop operation, so recording is not normally stopped.

25 In this embodiment, however, TOC information reflecting the contents of recording up to the point is recorded on the disk 1016 at the timing 1805 at which

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When the start of motion image recording is designated by the operation unit 1020, the system control circuit 1026 controls a picture rearrangement circuit 1022 to rearrange frames of an image signal from an image pickup unit 1001 as shown in Fig. 11, and outputs the signal to a switch 1003, a subtractor 1004 and a motion compensation prediction circuit 1011. After that, this motion image signal is encoded as described earlier by, e.g., a DCT circuit 1005, a quantization circuit 1006, a variable-length encoding circuit 1007, an inverse quantization circuit 1008, an IDCT circuit 1009, an adder 1010, and the motion compensation prediction circuit 1011. The encoded signal is output to a buffer 1013.

Also, an input audio signal from an audio input unit 1021 is encoded by an audio encoding circuit 1023 and output to a buffer 1024.

The operation of still image recording will be described next.

The recording apparatus of this embodiment has a still image recording mode. When still image recording is designated by the operation unit 1020 during recording of a motion image signal, a still image signal can be recorded on a disk 1016 independently of the motion image signal.

When the operation unit 1020 designates still image recording, the system control circuit 1026

outputs a control signal to the picture rearrangement circuit 1022 to extract image data of a frame, at the timing corresponding to the still image recording instruction, from an image signal having a plurality of frames output from the image pickup unit 1001. The extracted image signal is output to the still image encoding circuit 1027.

In accordance with a control signal from the system control circuit 1026, the still image encoding circuit 1027 receives the image data of one frame output from the picture rearrangement circuit 1002, encodes the data on the basis of a JPEG standard for still image encoding, and outputs the encoded still image data to the buffer 1028. The encoding scheme of this still image encoding circuit 107 is, of course, not limited to JPEG encoding. For example, base band encoding can also be performed. The still image encoding circuit 1027 performs real-time processing at a rate of, e.g., 4 Mbits/sec.

Under the control of the system control circuit 1026, a multiplexer 1025 time-divisionally multiplexes the motion image signal and audio signal stored in the buffer 1024, the still image signal stored in the buffer 1028, and TOC information stored in the buffer 1029 (as will be described later), and outputs the multiplexed data to a recording processing unit 1015. The recording processing unit 1015 records this

1GOP is composed of 15 frames.

When still image data is stored in the buffer 1028 in response to a still image recording instruction, the system control circuit 1026 controls the multiplexer 1025 to read out this still image data stored in the buffer 1028 by using a period during which recording of motion image data and audio data on the disk 1016 is stopped, i.e., a period 1401 shown in Fig. 14. The readout still image data is recorded in the still image recording area 902B different from the motion image recording area 902A on the disk 1016.

TOC data in this embodiment will be described below.

Fig. 22 is a view showing the contents of TOC data according to this embodiment.

The TOC of this embodiment has a scene table 2201 and a contents table 2202. The scene table 2201 shows the order of scenes and the correspondence between each scene and a row in the contents table 2202. In playback, scenes are usually reproduced in the order in this scene table 2201.

Also, the scene table 2201 can manage 4,095 scenes, and each scene has a 12-bit pointer which indicates a specific row in the contents table 2202. This scene table 2201 is used in order from 1, and a pointer having no corresponding scene has "0" which indicates the end.

00010000 10000000 00010000 10000000

The contents table 2202 has 4,095 rows, and each row has a start address 2203, an end address 2204, a link pointer 2205, and an attribution 2206. The start address 2203 and the end address 2204 are composed of 20 bits each and have the start and end addresses, respectively, of a corresponding scene.

The link pointer 2205 has a pointer indicating the row of the continuation of a scene, when a certain scene is connected to another scene to form one scene or when one scene is dispersedly recorded in discontinuous areas owing to the locations of empty areas. As indicated by an arrow in Fig. 22, when the continuation of a scene shown in row 1 of the contents table 2202 is shown in row 3, "3" is stored in the link pointer 2205 of row 1 to hold the continuity of the scene.

The attribution 2206 stores data indicating an attribution such as motion image, still image, or copy inhibition.

Data to be processed is, of course, not restricted to motion image, audio data and still image data but can be script data and the like. The type of data can be described in the attribution 2206 of the TOC data.

A summary of updating of TOC data as management information in the present invention will be explained below. Details will be described later.

When the power supply is turned on, only TOC data

is reproduced from the TOC recording area 901 on a recording medium and stored in the TOC memory 1018. The system control circuit 1026 can instantly know which data is stored in which area on the disk 1016 at present by referring to the TOC data loaded into the TOC memory 1018. To record a motion image and a still image, therefore, the system control circuit 1026 so controls as to record new data by designating an empty area on the basis of the TOC.

In this embodiment, whenever the operation unit 1020 designates still image recording, the system control circuit 1026 updates the TOC data stored in the TOC memory 1018 to have contents recorded up to that point, i.e., to have contents reflecting all pieces of information concerning motion image data recorded up to that point and still image data to be recorded henceforth.

The system control circuit 1026 outputs the TOC data having the updated contents to the buffer 1029 and records the still image data, stored in the buffer 1028, into the still image recording area 902B on the disk at the aforementioned timing. Subsequently, the system control circuit 1026 reads out the TOC data stored in the buffer 1029 and records the readout TOC data in the system management area 901 on the disk 1016. Also in this embodiment, whenever the operation unit 1020 designates the start and end of normal motion

image recording, the system control circuit 1026 updates the contents of the TOC data, supplies the updated TOC data from the TOC memory 1018 to the buffer 1029, and records the TOC data in the system management area 901 on the disk 1016.

Still image recording can be designated even while no motion image is being recorded. Also in this case, TOC data is updated and recorded on the disk 1016.

In this embodiment as described above, when recording of a still image is instructed while a motion image is being recorded, TOC data reflecting recorded contents is recorded on a disk at that time.

During image pickup of one scene, therefore, even when abnormality such as a decrease in remaining battery amount occurs and recording of a motion image is not normally terminated, if still image recording is designated at least once while a motion image is being picked up, TOC data reflecting recorded contents up to that point the still image data is recorded can be recorded on a disk.

Accordingly, the motion image data, audio data, and still image data recorded up to that point can be correctly reproduced.

The present invention can be applied to a system constituted by a plurality of devices or an apparatus comprising a single device.

Further, the objects of the present invention can

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codes, and the functions of the above embodiments are accomplished by the processing.

Many widely different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

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indicating an update state of the contents.

3. An apparatus according to claim 2, wherein
said control means detects the state of the management
5 information in accordance with the update information.

4. An apparatus according to claim 2, wherein the
update information is 1-bit digital information, and
said control means so controls said reproducing means
10 as to reproduce the management data when the update
information indicates a predetermined code.

5. An apparatus according to claim 1, wherein
said control means so controls said reproducing means
15 as to retrieve the management data recorded in the
first area in accordance with the management
information reproduced from the second area.

6. An apparatus for recording an image signal and
20 management information pertaining to the image signal
on a disk-like recording medium having a first area for
the image signal and a second area for the management
information, comprising:

recording means for recording the image signal and
25 the management information on said disk-like recording
medium;

storage means for storing the management

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information;

updating means for updating contents of the management information stored in said storage means in accordance with a recording operation of the image
5 signal of said recording means, the management information containing update information indicating an update state of the management information; and

control means for controlling said recording means so as to record the management information containing
10 the update information indicating a predetermined code in the second area before recording of the image signal is started, and record the management information which contains update information indicating another code and whose contents are updated by said updating means, in
15 the second area after the recording of the image signal is completed.

7. An apparatus according to claim 6, wherein the predetermined code indicates "not updated", and said
20 other code indicates "updated".

8. An apparatus according to claim 6, wherein said control means so controls said recording means as to record the management information containing the
25 update information indicating the predetermined code in the second area in accordance with designation of a start of recording by an operation switch, and record

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the management information which contains update information indicating said other code and whose contents are updated by said updating means, in the second area in accordance with designation of a stop of recording by the operation switch.

9. An apparatus according to claim 6, further comprising:

power supply means; and
10 detecting means for detecting electric power from said power supply means to output a detection signal indicating power reduction, and
wherein said control means so controls said recording means as to record management data concerning
15 an image signal recorded on said disk-like recording medium in the first area in accordance with the detection signal from said detecting means during recording of the image signal.

20 10. An apparatus according to claim 9, wherein said control means checks whether the update information contained in management information reproduced from the second area is the predetermined code and, if the update information is the
25 predetermined code, so controls said updating means as to modify the management information on the basis of the management data reproduced from the first area.

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11. An image pickup apparatus for encoding an image signal obtained by image pickup means and recording the encoded image signal and management information pertaining to the image signal on a
5 disk-like recording medium having a first area for the image signal and a second area for the management information,

wherein when a decrease in electric power from power supply means is detected, management data
10 concerning an image signal recorded on said disk-like recording medium is recorded in the first area.

12. An apparatus for recording an information signal and management information pertaining to a
15 recording address of the information signal in a disk-like recording medium having a first area for the information signal and a second area for the management information, comprising:

storage means for storing the management
20 information;

updating means for updating contents of the management information stored in said storage means in accordance with a recording operation of the information signal;

25 encoding means for encoding an input information signal;

recording means for recording the information

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signal encoded by said encoding means and the updated management information on the disk-like recording medium;

state detecting means for detecting the state of
5 the input information signal; and

control means for controlling said updating means to update contents of the management information in accordance with an output from said state detecting means, and controlling said recording means to record
10 the updated management information in the second area of the disk-like recording medium.

13. An apparatus according to claim 12, wherein the information signal contains a motion image signal
15 having a plurality of frames, and said state detecting means detects a degree of change between images of said plurality of frames.

14. An apparatus according to claim 13, wherein
20 said control means outputs a timing signal when the change amount between the images of said plurality of frames exceeds a predetermined value, and controls said updating means and said recording means in accordance with the timing signal.

25

15. An apparatus according to claim 14, wherein said recording means intermittently records the motion

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image signal on the disk-like recording medium, and
said control means so controls said recording means as
to record the management information during a recording
stop period of the motion image signal in accordance
5 with the timing signal.

16. An apparatus according to claim 15, wherein
said recording means comprises a buffer memory for
storing a motion image signal encoded by said encoding
10 means and the updated management information, and said
control means controls the timing at which the
management information is output from said buffer
memory.

17. An apparatus according to claim 12, wherein
the information signal contains an audio signal, and
said state detecting means detects the level of the
audio signal.

18. An apparatus according to claim 17, wherein
said control means outputs a timing signal when the
level of the audio signal is not more than a
predetermined value, and controls said updating means
and said recording means in accordance with the timing
25 signal.

19. An apparatus according to claim 18, wherein

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said recording means intermittently records the audio signal on the disk-like recording medium, and said control means so controls said recording means as to record the management information during a recording stop period of the audio signal in accordance with the timing signal.

20. An apparatus according to claim 12, wherein a recording data rate of said recording means is higher than a data rate of an information signal encoded by said encoding means.

21. A recording apparatus for recording a motion image signal and management information pertaining to a recording address of the motion image signal on a disk-like recording medium having a first area for the motion image signal and a second area for the management information,

wherein a change between pictures of an input motion image signal is detected, and the management information is recorded in the second area of the disk-like recording medium when the change between the pictures is detected during recording of the motion image signal.

22. An apparatus for recording an image signal and management information pertaining to a recording

address of the image signal on a disk-like recording medium having a first area for the image signal and a second area for the management information, comprising:

5 storage means for storing the management information;

recording means for recording a motion image signal and a still image signal in the first area of the disk-like recording medium and recording the management information in the second area; and

10 control means for controlling said recording means to record the management information in the second area of the disk-like recording medium in accordance with designation of still image recording which is provided during recording of a motion image signal.

15 23. An apparatus according to claim 22, wherein said control means records the management information in the second area of the disk-like recording medium in accordance with designation of stop of recording of a motion image signal.

24. An apparatus according to claim 22, further comprising updating means for updating contents of management information stored in said storage means in
25 accordance with a recording operation of the image signal to said disk-like recording medium, and wherein said control means so controls said

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updating means as to update contents of the management
information in accordance with designation of still
image recording which is provided during recording of
the motion image signal, and said recording means
5 records the updated management information in the
second area.

25. An apparatus according to claim 24, wherein
said control means so controls said updating means as
10 to update contents of the management information in
accordance with designation of a stop of recording of a
motion image signal.

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ABSTRACT OF THE DISCLOSURE

A recording apparatus of this invention detects the state of management information, which pertains to a recording address of an image signal, and which is reproduced from a disk-like recording medium having a first area for the image signal and a second area for the management information. On the basis of the detection result, management data is reproduced from the first area of the disk-like recording medium. On the basis of the management data reproduced from the first area, the management information reproduced from the second area is modified. A modify unit records the modified management information in the second area.

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FIG. 1

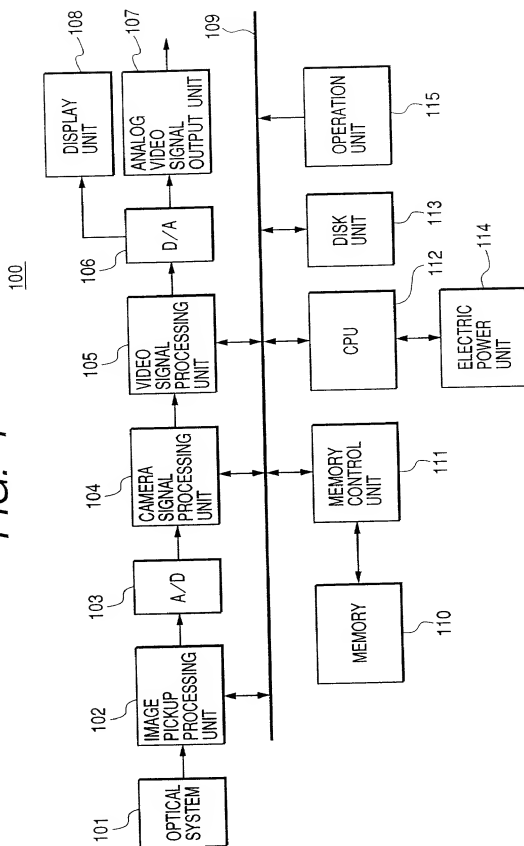


FIG. 2

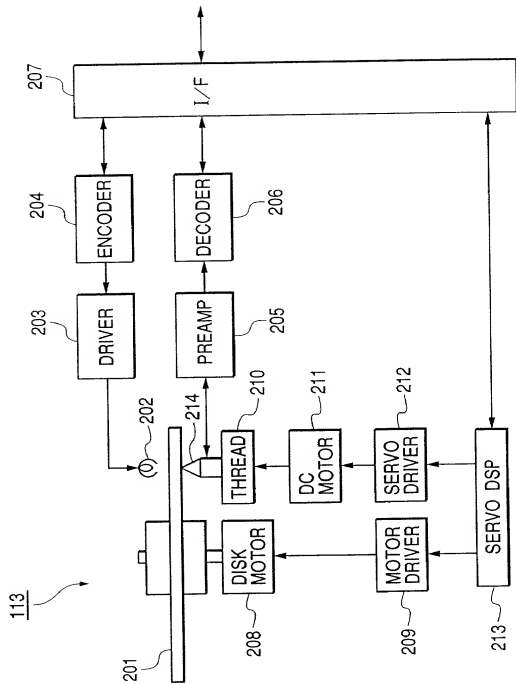
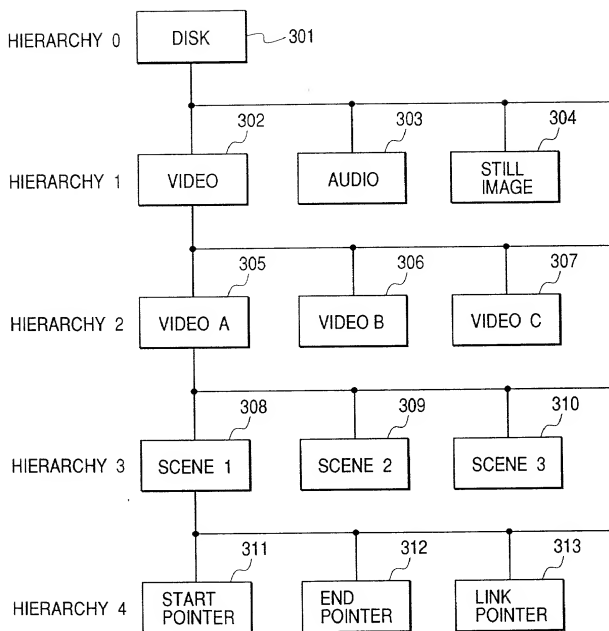


FIG. 3



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FIG. 4

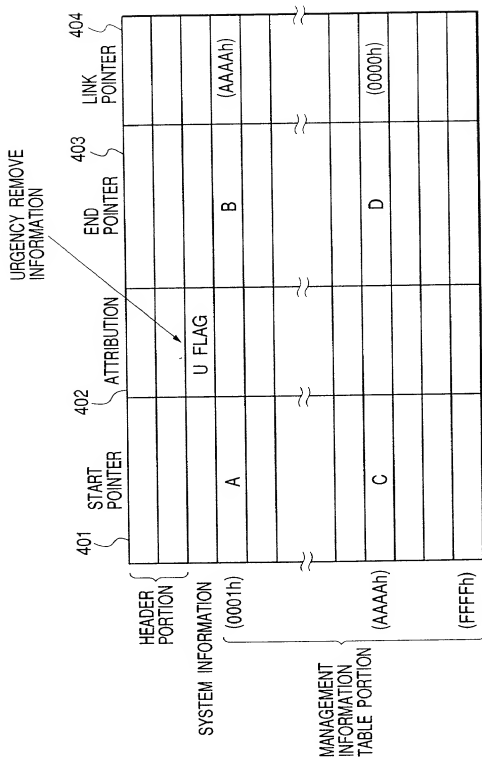


FIG. 5

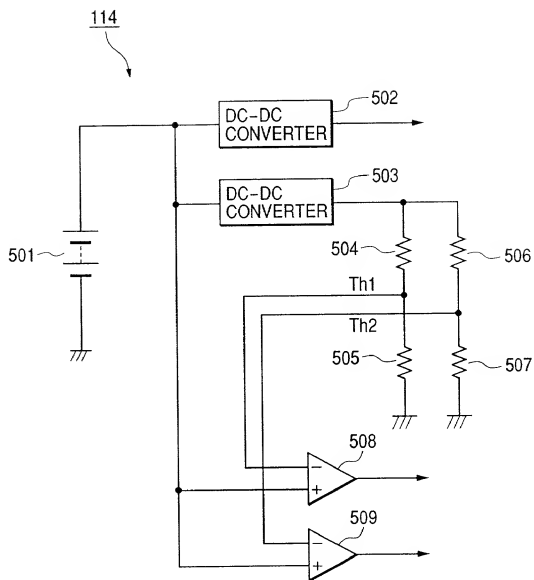


FIG. 6

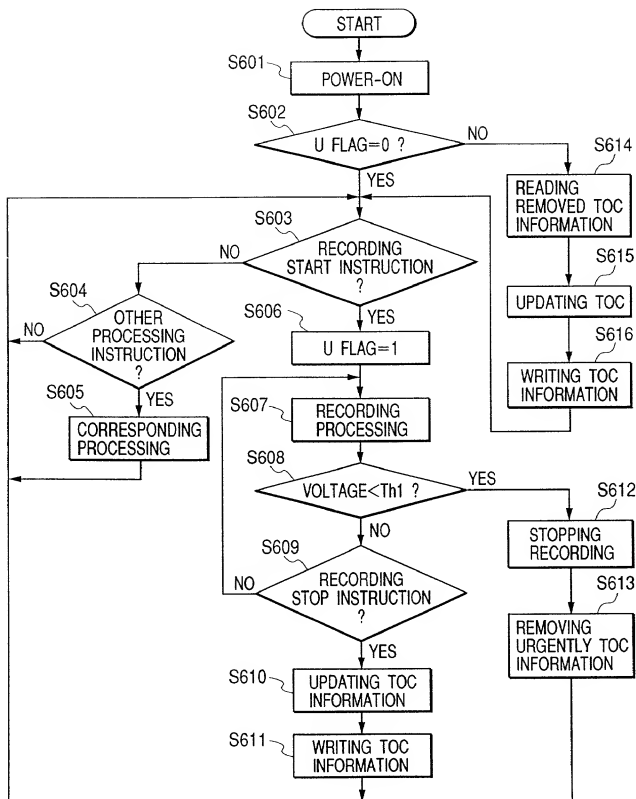


FIG. 7

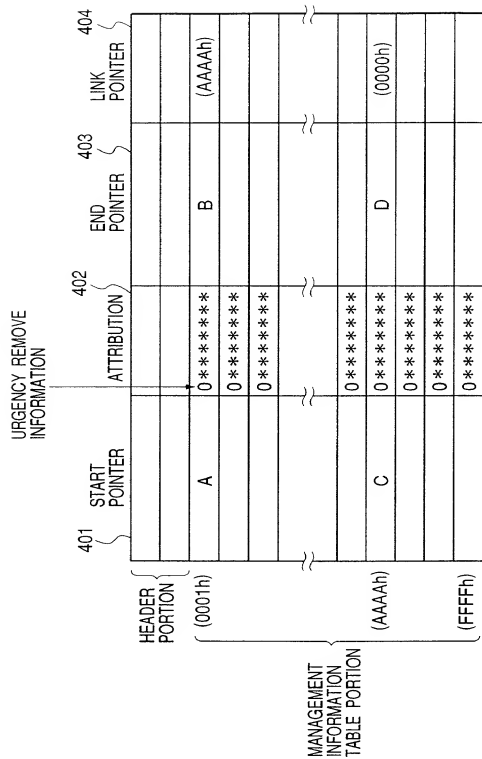


FIG. 8

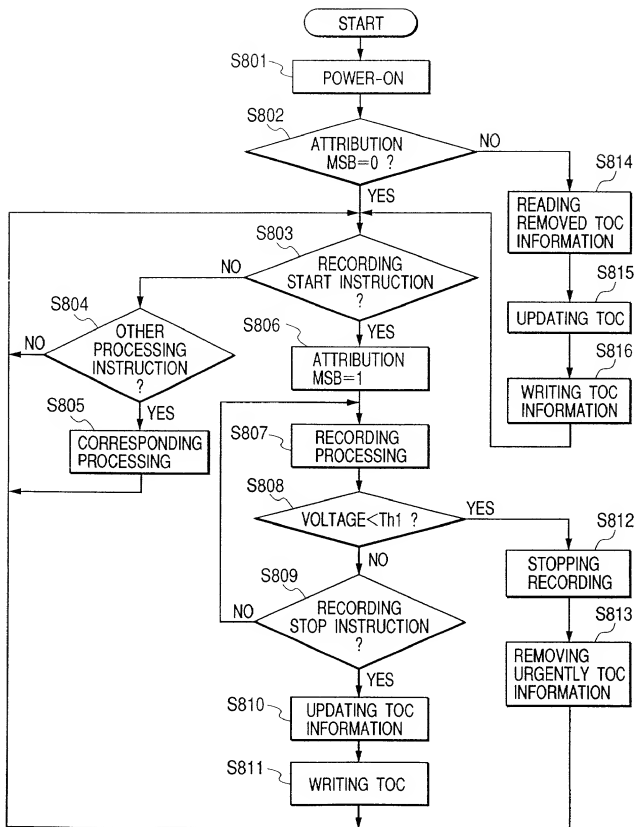


FIG. 10

1000

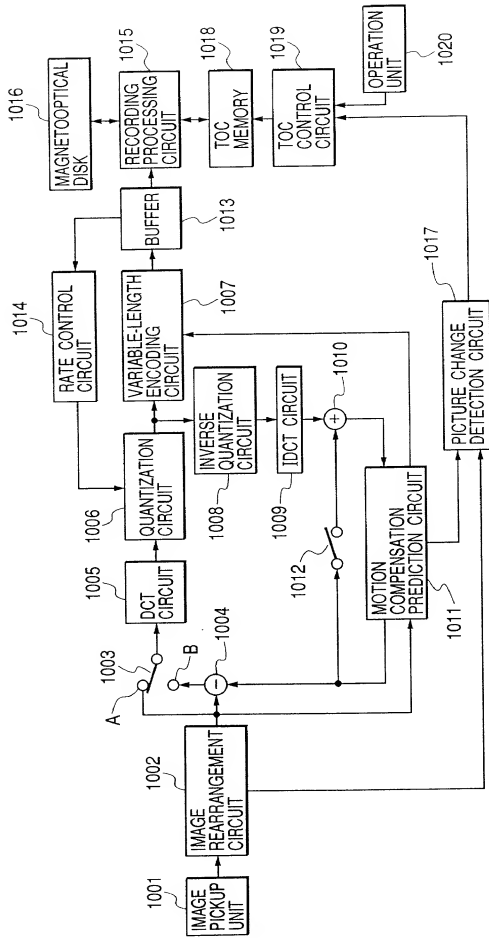


FIG. 11

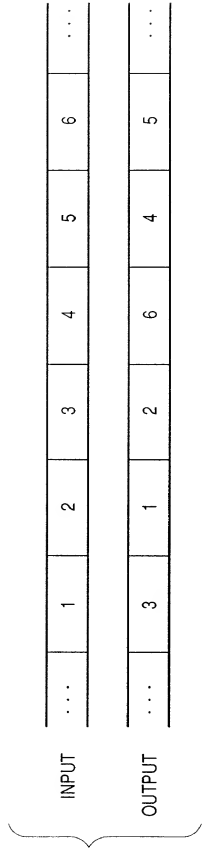


FIG. 12

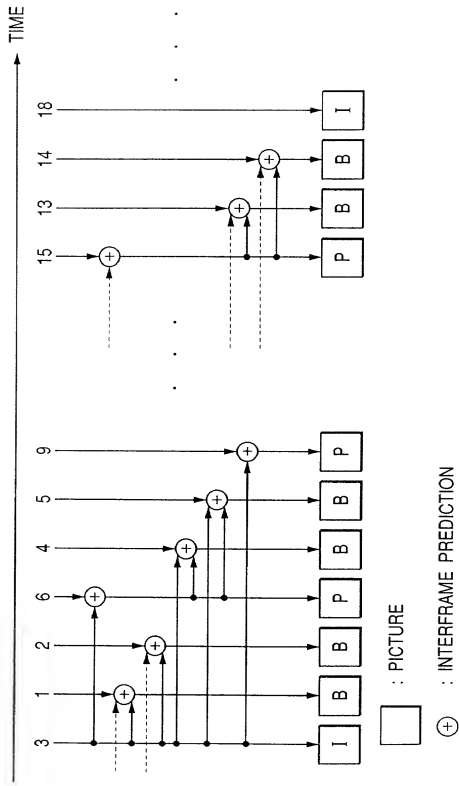


FIG. 15A

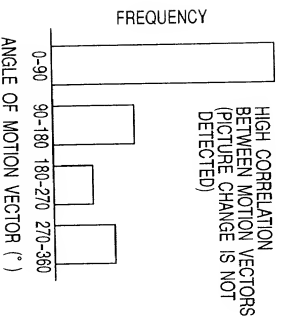


FIG. 15B

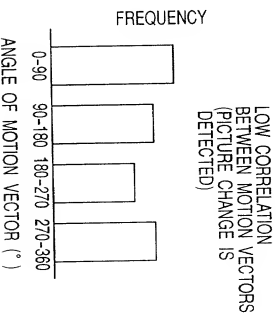


FIG. 16

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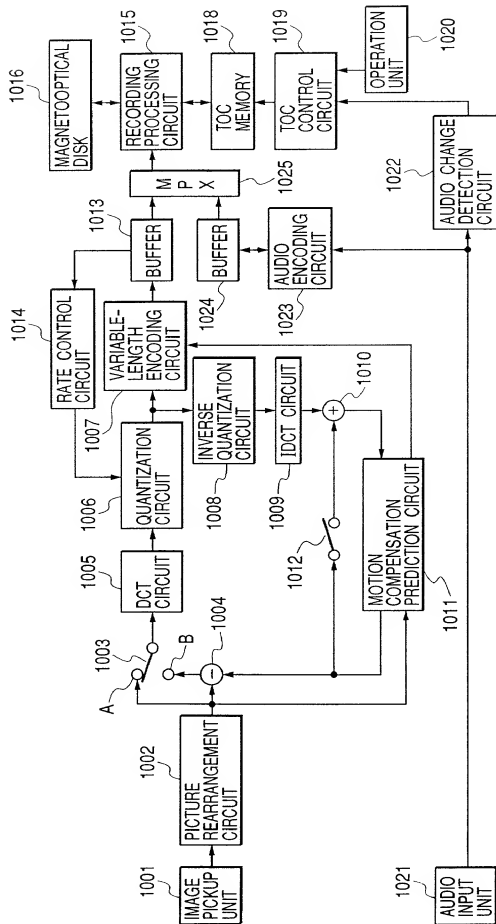


FIG. 17

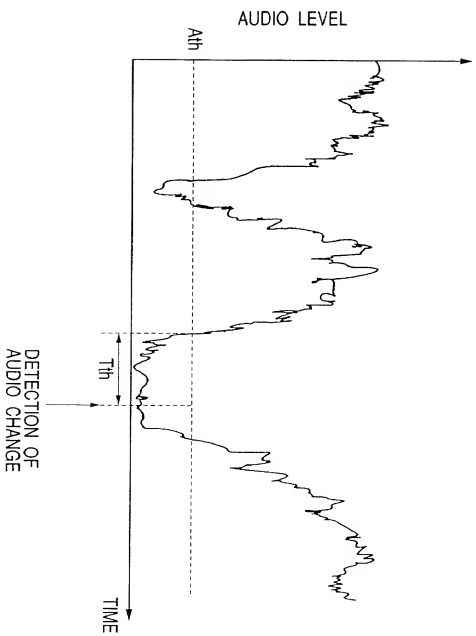


FIG. 18

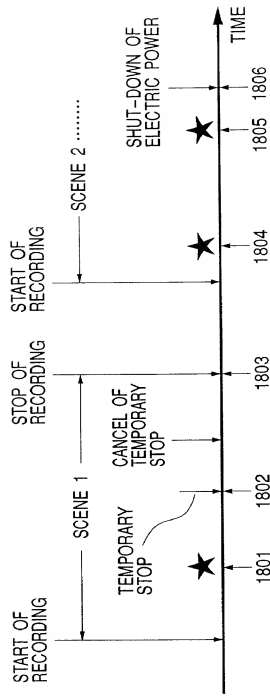


FIG. 19

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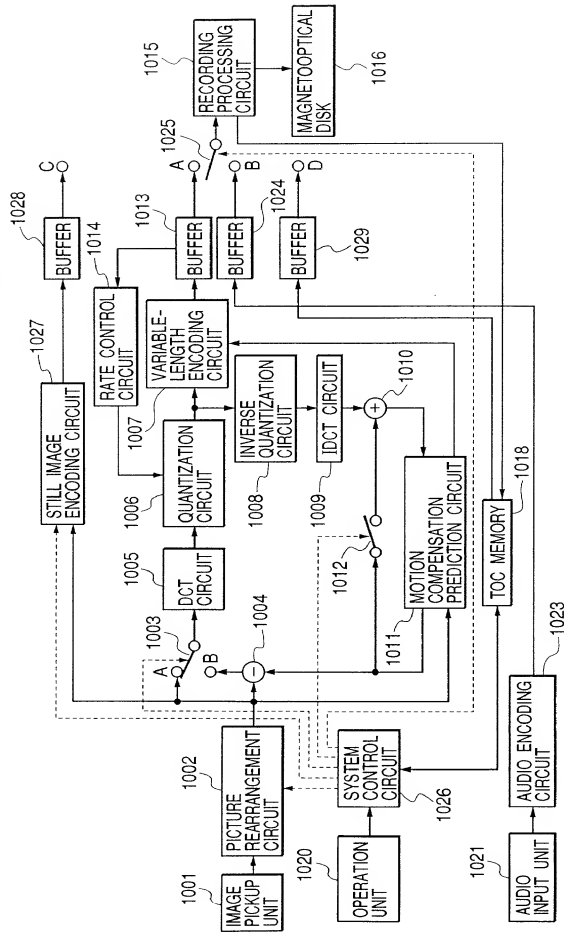


FIG. 20

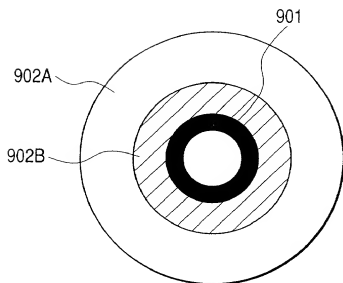


FIG. 21

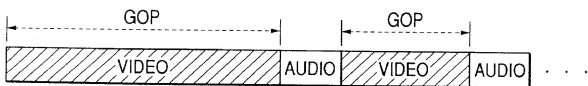


FIG. 22

